(12) UK Patent Application (19) GB (11) 2 288 636 (13) A

(43) Date of A Publication 25.10.1995

(21) Application No 9407377.2

(22) Date of Filing 14.04.1994

(71) Applicant(s)
Ford Motor Company Limited

(Incorporated in the United Kingdom)

Eagle Way, BRENTWOOD, Essex, CM13 3BW, United Kingdom

(72) Inventor(s)
Ian Coroon Middleton

(74) Agent and/or Address for Service
A Messulam & Co
24 Broadway, LEIGH-ON-SEA, Essex, SS9 1BN, United Kingdom

(51) INT CL[6]
F01L 13/00

(52) UK CL (Edition N)
F1B BBA BB130 BB210 BB250 BB258 BB270

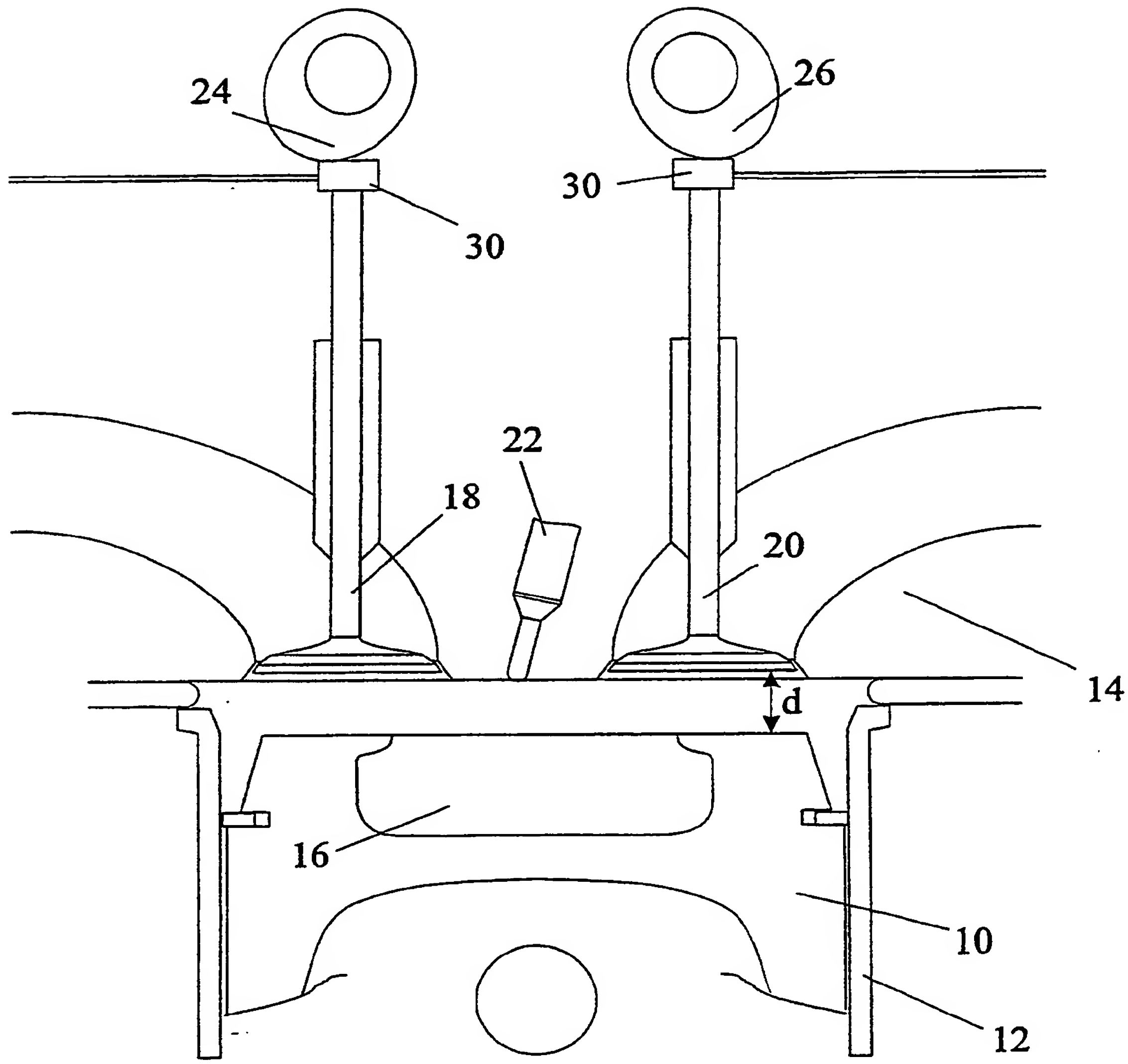
(56) Documents Cited
None

(58) Field of Search
UK CL (Edition M) F1B
INT CL[5] F01L 1/46 13/00 31/00
ONLINE DATABASE : WPI

(54) **Diesel engine valve gear**

(57) To prevent damage due to collision of the piston with the intake and exhaust valves in an engine with variable valve lift or timing the means effecting variation is suitably adjusted. The adjustment may be responsive to engine temperature, the onset of minor collision, e.g. by a knock sensor or detection of pressure pulses in an hydraulic tappet circuit, or the ultrasonic detection of the minimum piston and valve spacing.

GB 2 288 636 A


24
26
30
30
22
18
20
14
d
16
10
12

2288636

Diesel Engine

The present invention relates to a diesel engine.

In the design of diesel engines, the piston is required to close to the intake and exhaust valves when it is at the top of its exhaust stroke in order to minimise parasitics. This however presents a problem because manufacturing tolerances result in variation in piston sizes and because the dimensions of the pistons change with operating conditions. To take these variations into account, the engine designer must allow for the worst case in order to avoid collision between the piston and the valves under all conditions, as the engine could otherwise be seriously damaged.

With a view to mitigating this disadvantage, the present invention provides a diesel engine including a variable valve train and means for acting on the variable valve train to vary the amplitude of valve lift or the phase of opening and closing of the intake and exhaust valves in order to avoid damage to the engine by collision of the piston with the intake and exhaust valves.

Mechanisms are known for permitting the amplitude of valve lift to be modified. For example, in an engine in which a rocker is employed to transmit force from a cam follower to a valve, movement of the fulcrum of the rocker modifies its mechanical advantage and varies the amplitude of valve movement.

Numerous mechanisms are also known for varying the phase of a camshaft relative to the engine crankshaft. Such mechanism may for example include a helical gear on the camshaft engaging with a second gear driven by the crankshaft. Axial displacement of the second gear relative to the helical gear will cause a phase shift between the camshaft and the crankshaft. Other mechanisms previously

proposed are even more compact and can be entirely housed within the drive pulley of the camshaft.

Still further mechanisms are known that allow the valve event duration to be varied, for example by incorporating cams with different profiles, and selecting between different rockers interposed between the cam followers and the valves.

The above mechanisms, all of which are known per se and need not therefore be described in detail, can be used in the present invention to enable the clearance between the piston and the valves to be minimised under all operating conditions, thereby improving the combustion quality of the engine which in turn leads to better performance and lower emissions.

Collision between the valves and the piston can be avoided using the above mechanisms by reducing the amplitude of opening of the valves, advancing closing of the exhaust valve and retarding the opening of the intake valve whenever the engine is at risk of damage.

The risk of collision increases with temperature and in a first embodiment of the invention, means are provided for acting on the valve train in dependence upon engine temperature in order to reduce the risk of damage to the engine.

By calibration, it is possible to determine how the clearance between the valves and the piston reduces with temperature and allow for thermal expansion by modifying the valve train as a function of temperature. This however does not allow for wear, variations between one engine and another nor between one cylinder and another of the same engine.

To allow for such variations, in a further embodiment of the invention, means are provided for sensing the onset of collisions between a valve and the piston and acting on the valve train to avoid damage to the engine.

Because changes in temperature and piston expansion will occur over several engine cycles, at the onset of collision there will be only light contact between the piston and the valve that is not sufficient to cause damage but is nevertheless detectable. By using for example a load cell or knock sensor in the valve train it is possible to detect such onset and initiate action to increase the minimum clearance between the valves and the piston.

As a still further possibility, one can also envisage the use of ultrasonics to provide a direct measurement of the minimum clearance between the valves and the piston and to act on the valve train accordingly.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which the single figure shows the combustion chamber of a diesel engine.

In the drawing, a piston 10 reciprocates within a cylinder 12 having a cylinder head 14. Combustion takes place in a bowl 16 recessed into the piston 10. The cylinder head 14 is generally flat and has an intake poppet valve 18, an exhaust poppet valve 20 and a high pressure injector 22. The valves 18 and 20 are operated by a variable valve train that is schematically represented in the drawing by two direct acting cams 24 and 26.

At top dead centre at the end of the compression stroke, it is desirable in order to improve combustion quality to minimise the distance between the piston crown and the cylinder head. However, at top dead centre at the end of the

exhaust stroke and the commencement of the intake stroke, both the valves 18 and 20 are partly open, and if the distance d between the piston crown and the open valves is minimised, there is a risk because of accumulated tolerances and thermal expansion that the piston 10 might collide with the heads of the poppet valves 18 and 20 and cause engine damage.

In the present invention, such damage is avoided by acting on the valve train to reduce the valve height at this instant. This may be achieved in a variety of ways that are known per se and which, for this reason, need not be described in detail within the present context.

One way of increasing the clearance between the valves and piston is to advance the closing of the exhaust valve and retard the opening of the intake valve. One may for this purpose use known mechanisms to shift the phases of the cams 24 and 26 relative to the crankshaft of the engine or use switchable or variable cams to vary the duration of the valve events, i.e. the periods that the valves remain open.

As an alternative, the valve mechanism may be one that provides variable lift. The lift may be varied for example by using three dimensional cams or by varying the fulcrum of rockers interposed in the drive train between the cams and the valves.

Various methods of control may be adopted to prevent engine damage by acting on the variable valve train. The clearance between the valves and the piston will vary as a function of temperature. If the clearance is known when the engine is cold, then the risk of collision can be determined by measurement of engine temperature alone. In its simplest embodiment, the invention may be implemented by acting on the variable valve train in dependence only upon the measured engine temperature.

To operate at the minimum possible clearance and take account of variations caused by wear and manufacturing tolerances, it is possible to detect the onset of collision and to act on the variable drive train only after such collisions are detected. When contact commences, the extent of the collisions will not be sufficient to cause engine damage but can be detected by a load cell or pressure sensor 30 positioned in the cam follower or by a knock sensor. For example, if hydraulic tappets are used, contact between the piston 10 and the valves 18, 20 may be sensed by surges in pressure in the hydraulic circuit supplying the tappets.

It may as a further alternative be possible to effect direct measurement of the minimum distance between the valves 18, 12 and the piston 10, for example using ultrasonic techniques, and to act on the variable valve train when collision is imminent.

CLAIMS

1. A diesel engine including a variable valve train and means for acting on the variable valve train to vary the amplitude of valve lift or the phase of opening and closing of the intake and exhaust valves in order to avoid damage to the engine by collision of the piston with the intake and exhaust valves.

2. An engine as claimed in claim 1, wherein the variable valve train is controlled in dependence upon engine temperature.

3. An engine as claimed in claim 1, comprising means for detecting the onset of collision between the valves and the piston and acting on the variable valve train to increase the minimum clearance between the valves and the piston.

4. An engine as claimed in claim 3, wherein the engine is fitted with hydraulic tappets and the means for detecting the onset of collision between the piston and the valves is operative to sense pressure pulses in the hydraulic circuit of the tappets.

5. An engine as claimed in claim 1, comprising means for directly measuring the clearance between the piston and the valves and for acting on the variable valve train to maintain the clearance above a predetermined minimum value.

7

Patents Act 1977
F·aminer's report to the Comptroller under Section 17
(. ıe Search report)

Application number
GB 9407377.2

Relevant Technical Fields

(i) UK Cl (Ed.M) F1B

(ii) Int Cl (Ed.5) F01L 1/46, 13/00, 31/00

Search Examiner
R J DENNIS

Date of completion of Search
11 MAY 1994

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASE: WPI

Documents considered relevant following a search in respect of Claims :-
1 TO 5

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
	None	

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).